Deriving the Ontological Foundation of Field Theories Using Classical Logic: Addressing Hilbert's Sixth Problem

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Abstract

The purpose of this work is to establish an axiomatic system for deriving physics, mathematics, ontology, and related fields of philosophy using the same rules of inference. Within this system, the existence of an entity Z is defined through intrinsic, non-geometric properties via the biconditional $P(Z) \iff E(Z)$, and ontology is identified as the set of logical rules and structures derivable therefrom. Equations of physics are interpreted as modeling these existing entities. Under this framework, coordinate time is treated as an intrinsic property rather than a geometric dimension. Applying this interpretation to the ADM formalism yields a description in which a single spatial slice is ontologically fundamental and evolves according to its intrinsic properties. The geometric dynamics associated with curvature are reformulated as variations in the density of a quantized medium confined to $\mathbb{R}^3$, providing a fixed background structure. **Equations break down, but logic (not the same) remains constant establishing a means of addressing paradoxes.**

1 Introduction

Assume that the equation $x = y \cdot z$ accurately models some observation over n scientific experimental tests. Even in the context where $n \to \infty$, this would not permit us to determine the ontological meaning of x, y, and z. That is, equations establish relationships between variables, but they don't let us derive the meaning of the variables themselves. If we are instead given the equation in $d = v \cdot t$ form, we have some preconceived ideas about what distance, velocity, and time are that at least make us believe that we understand this second form of the equation more than the first. However, no (known) principle establishes that any initial assumptions about what these variables mean correctly correspond to their physical meaning in reality. Thus ontology is not derivable from mathematics.

For a theoretical statement or claim X to make sense, it must be derivable ($\Sigma \vdash_L X$) within some axiomatic system $(\Sigma, \vdash_L)$ in which a contradiction can't be derived ($\Sigma \nvdash_L \perp$) [1,2], formally expressed as,

$$MakesSense(X) \iff \exists(\Sigma, \vdash_L)\left[(\Sigma \nvdash_L \perp) \wedge (\Sigma \vdash_L X)\right].$$

So while equations give correct relationships between the variables, if the goal is to make sense of data and understand what variables are in a way that is consistent across physics, then a single axiomatic system would have value.

While the foundations of general relativity (GR) and quantum field theory (QFT) are consistent, there are tensions within specific models. For example, standard QFTs are formulated on a fixed spacetime background, whereas GR treats spacetime geometry as dynamic [3,4]. However, it is these specific models that have been numerically verified, so we want to be able to unite them on the same ontological structure without losing their numerical precision. Thus, rather than assuming the meaning of variables, we logically derive them, and this allows us to alter the ontological structure on which each theory depends until they are the same. The method is as follows:

1. Use $P(Z) \iff E(Z)$ to derive the meaning of $Space$ and time using classical logic.
2. Derive field equations, that represent existence as a function of $Space$ and time (ontology).
3. Construct a universal ontology, referred to as U, tied to these ontological field equations such that all known phenomena share a common mechanism.
4. Tie the gravitational, scalar, fermion, and gauge fields to U while preserving numerical predictions.

2 The Axiomatic System

Logic is the study of valid reasoning, and is independent of the specific axioms used [1]. However, if the axioms are not true, the system is not dependable for understanding reality. What is therefore necessary is to establish a formal system in which all of the axioms are true, and in which all methods used to analyze reality can be derived. We are thus looking for an axiomatic system that incorporates

$$\underbrace{(\Sigma_{\text{math}}, \vdash_L)}_{\text{Theorems}} \sqcup \underbrace{(\Sigma_{scie}, \vdash_L)}_{\text{Science}} \sqcup \underbrace{(\Sigma_{\text{onto}}, \vdash_L)}_{\text{Ontology}} \sqcup \underbrace{(\Sigma_{\text{phil}}, \vdash_L)}_{\text{Philosophy}},$$

where the axioms are defined as follows:

Σ_{math} = von Neumann–Bernays–Gödel (NBG) set theory,

L = Classical Logic,

$\Sigma_{\text{scie}} = \{\beta|\beta$ is a scientifically confirmed observation$\}$,

$\Sigma_{\text{onto}} = P_\sigma(Z) \iff E_\sigma(Z), \{\sigma\}$,

- $Z \in \{z|z$ is a real or imagined entity$\}$.
- σ: An intrinsic property (of an entity) that is independent of the mind and geometrical characteristics.
- $P_\sigma(Z)$: $\forall\sigma$, $\forall Z$, $P_\sigma(Z) \in [0,1]$ where:
  (a) $P_\sigma(Z) = 1 \implies \sigma \in \{\sigma(Z)\}$.
  (b) $P_\sigma(Z) = 0 \implies \sigma \notin \{\sigma(Z)\}$.
- E: Represents existence where:
  (a) $E(Z) = 1 \implies Exists(Z)$.
  (b) $E(Z) = 0 \implies \neg Exists(Z)$.
  (c) $E(Z) = max\{E_\sigma(Z)\}$.

$\Sigma_{\text{phil}} = \{C|\Sigma_{\text{math}} \cup \Sigma_{\text{scie}} \cup \Sigma_{\text{onto}} \cup \{C\} \nvdash_L \perp\}$.

All concepts and thought processes (C) are permitted provided that they are not ruled out by the other axioms, creating a self correcting framework. There are no claims that this system is complete, only that it is consistent, thus avoiding complications with **Gödel's incompleteness theorems** [5]. While this framework should be continuously built upon (e.g., adding engineering and chemistry), it was labeled by a colleague as the framework of everything (FOE), and is formally represented as:

$$FOE = \left(\Sigma_{\text{math}} \cup \Sigma_{\text{scie}} \cup \Sigma_{\text{onto}} \cup \Sigma_{\text{phil}}, \vdash_L\right). \quad (1)$$

Classical logic has a well defined implication and contrapositive, but the converse isn't always true [1]. Thus, for any specific property s, and any entity Z, if Z is not defined by s (the electron is defined to have charge), the following holds:

(i) $P_s(Z) \implies E(Z)$: If entity Z possesses the property of s, then Z must exist.

(ii) $\neg E(Z) \implies \neg P_s(Z)$: If entity Z does not exist, then it cannot possess the property of s.

(iii) $\neg(E(Z) \implies P_s(Z))$: It is not the case that the existence of Z implies that Z possesses the specific property of s.

Law of Interaction. The following criteria determine whether an entity Z possesses the property of interaction $\mathcal{I}$, and $s = \mathcal{I}$ in (i)-(iii) are the ontological rules:

$$\mathcal{I} \in \{\sigma(Z)\} \iff \exists Z_i(|\Psi^U_{\{Z_i,Z\}}(t,\vec{x})| \neq 0). \quad (2)$$

- $\Psi^U_{\{Z_i,Z\}}(t,\vec{x})$: The wave-function of the interaction.
- $Measurable$: $|\Psi^U_{\{Z_i,Z\}}(t,\vec{x})| \geq D_{\{Z_i,Z\}}$.
- $D_{\{Z_i,Z\}}$: The minimal detectable magnitude set by current technology (independent of proximity).

Setting $s = Measurable$: It follows that if Z is measurable, then Z exists; and that we can consider that Z exists even if Z isn't measurable. This establishes that realism [6] always holds.

Since mathematics doesn't have intrinsic properties, it is not a causal or structural agent (it's purely descriptive).

Law of Self-Causation (time): The following criteria determine whether an entity Z possesses the property of self-causation $\mathcal{S}$, and $s = \mathcal{S}$ in (i)-(iii) are the ontological rules:

$$\mathcal{S} \in \{\sigma(Z)\} \iff \exists\, \mathbf{t}(\mathbf{t} \in D_{S_Z} \wedge S_Z(\mathbf{t}) \neq 0). \quad (3)$$

- $S_Z := s_{\alpha Z}(t) \in C, \quad \alpha \neq \alpha(t), \quad \alpha \in \mathbb{R}$.
- $s_{\alpha Z} : Time \to IntrinsicState$.
- α: Defined as the property of free-will (not implied).

This establishes that if an entity doesn't exist, it can't cause itself to exist; and that causal motion, what we associate with time, can either be an intrinsic property or a result of external factors like the curvature of spacetime.

Closed time-like curves (CTC) have been investigated by physicists like Godel [7] and Friedman [8]. Instead of the CTC being defined in spacetime, within U they are causal loops S_Z intrinsic to Z, to the same extent that charge is an intrinsic property of an electron.

α quantifies the property by which Z changes states. In the case that $\alpha = const$, then the intrinsic state of Z is deterministic, but if α varies, since it is not a function of time, it would represent the property of bounded free will.

The operator $*$ denotes the compositional aggregation of the intrinsic state functions, where the resulting value represents the net available internal state freedom of the system, defined as:

$$S_{\{Z_i\}_{i=1}^{j}}(t) = S_{Z_1}(t) * S_{Z_2}(t) * \dots S_{Z_j}(t) \tag{4}$$

where $S_{\{Z_i\}_{i=1}^{j}}(t)$ drives the interaction, represented as

$$S_{\{Z_i\}_{i=1}^{j}}(t) \overset{Drives}{\longrightarrow} \Psi^{U}_{\{Z_i\}_{i=1}^{j}}(t, \vec{x}). \tag{5}$$

Each Z intrinsically produces internal changes that result in interactions, and those interactions give Z spatial variance that produce the statistical outcomes of QM. Furthermore, $Space$ and time are now ontologically decoupled.

Laws of Ontological Continuity:

Claim: The totality of existence is fixed, and all formations are permutations thereof.

Proof: By the Laws of Self-Causation and Interaction,

$$[P_{\mathcal{S}}(Z) \implies E(Z)] \wedge [P_{\mathcal{I}}(Z) \implies E(Z)] \tag{6}$$
$$\therefore P_{\mathcal{S}}(Z) \vee P_{\mathcal{I}}(Z) \implies E(Z). \tag{7}$$

If Z can begin to exist from non-existence then Z must either begin intrinsically or be caused extrinsically, represented as

$$CanBeginE(Z) \implies P_{\mathcal{S}}(Z) \vee P_{\mathcal{I}}(Z) \tag{8}$$
$$\therefore CanBeginE(Z) \implies E(Z). \tag{9}$$

It follows that if Z can begin to exist, then it already exists, contradicting the claim that it can begin to exist. Thus,

$$\neg E(Z) \implies \neg CanBeginE(Z), \textit{ and} \tag{10}$$
$$E(Z) \implies D_{S_Z} = (-\infty, \infty). \tag{11}$$

If Object O forms, it therefore follows that it's formed from pre-existing entities. QED

This establishes that everything that has a beginning (stars, particles), is created from permutations of that which has always existed. It should be clarified that "only existence exists," and thus stars do not exist, but rather the word star describes the permutation of existences that we associate with the object.

Law of Spatial Isomorphism:

$Space$: The closed and connected geometry in which everything that exists, exists.

Claim: $Space \cong \mathbb{R}^n$ for some $n \geq 3$, permitting unbounded translational freedom.

Proof: Let $Space \cong X \subsetneq \mathbb{R}^n$ where $dim(X) = n$. By definition, everything that exists, exists within $Space$. By the Law of Interaction, nothing exists exterior to $Space$ to form a boundary. This establishes the isomorphism by contradiction, and

$$\neg E(Space) \implies \neg P_{\mathcal{I}}(Space) \tag{12}$$

establishes unbounded translational freedom. QED

2.1 The $0 \cdot \infty$ Indeterminate Forms

In standard analysis, infinity represents the concept of being unbounded, and thus notations such as $0 \cdot \infty$ are generally regarded as indeterminate forms [9]. However, by the Law of Ontological Continuity, existence has always existed and continues existing, and thus it is necessary to incorporate the surreal numbers **No** to deal with the mathematics of exceeding infinity.

Axiom 1 (Law of Identity): $\forall x \in \textbf{No}$, $x = x$.

Thus, $\infty \neq \infty + 1 \implies \frac{1}{\infty} \neq \frac{1}{\infty+1} \neq 0$.

Axiom 2 (Mathematical Representation of the Law of Ontological Continuity): $\forall x \in \textbf{No}$, $0 \cdot x = 0$.

It is not feasible to take even an infinite number of entities that don't exist, and obtain non-existence, mathematically represented as $0 \cdot \infty = 0$.

Axiom 3 (Law of Operational Realism): Every mathematical operation permitted within physics, must correspond to a physical operation, or represent non-existence.

Each mathematical step must precisely translate the physical world into the mathematical one. It is not possible to take something that doesn't exist and perform an operation with it. Existence is what preserves scale.

Axiom 4 (Law of Inverses): $\forall x \in \textbf{No} \setminus 0$, $x \cdot x^{-1} = 1$.

2.1.1 Limits, Dirac Delta, Volumetric Existence

Claim 1: If the limit of two functions is non-zero, then neither function becomes identical to zero in the limit.

Proof: Let $\lim_{x\to a} f(x) \to 0$, $\lim_{x\to a} g(x) \to \infty$, and $\lim_{x\to a} f(x)g(x) \neq 0$. It follows that

$$\lim_{x\to a} f(x)g(x) \neq [\lim_{x\to a} 0 \cdot g(x) = 0] \quad \text{(by axiom 2)}$$

to which we conclude that $\lim_{x\to a} f(x) \neq 0$. QED

Claim 2: The Dirac delta function doesn't align with the rules of ontology.

Proof: The Dirac delta function $\delta(x)$ is primarily motivated by taking the limit in which the width of the bell curve approaches zero [10]. Let $f(\sigma, x) = e^{-\frac{1}{2}(\frac{x-\mu}{\sigma})^2}$, and $g(\sigma) = \frac{1}{\sigma\sqrt{2\pi}}$ express components of the Gaussian. Since

$$\lim_{\sigma\to 0} f(\sigma, x \neq \mu) g(\sigma) \neq 0$$

by Claim 1, the mathematical limits of the Gaussian don't apply to anything point-like. Thus, the underlying motivation for the Dirac delta isn't supported by the mathematics.

If we then analyze the formal definition of the Dirac delta where $\delta(x-\alpha) = 0\, \forall x \neq \alpha$, $\delta(x-\alpha) = \infty$ for $x = \alpha$, and $\int_{-\infty}^{\infty} \delta(x-\alpha)\, dx = 1$ [10], this is equivalent to defining $0 \cdot \infty = 1$, contradicting Axiom 2. QED

Remark: The Dirac delta function is a phenomenal contribution because it allows for tremendous simplification; it is only necessary to know its limits.

Claim 3: Existence requires volume ($E(Z) \implies V(Z)$).

Proof: Let Z_0 be a point entity with property density ρ_0, a corresponding measure $V_0 = 0$, and unit conversion κ. From Axiom 2, Claim 1, and Claim 2,

$$\lim_{\rho\to\infty} \rho_0 V_0 = \int_{-\infty}^{\infty} \kappa\delta(x)\rho_0 dx = \rho_0 V_0 = 0 \implies \neg E(Z_0).$$

$A(Z)$: Entity Z has a non-zero area.
$BindFlux(Z)$: Entity Z has an internal binding flux.

Let Z_1 be a 1-dimensional entity, and Z_0 represent the properties at an internal point of Z_1. Then

$$DividesZ_1(Z_0) \wedge \neg E(Z_0) \wedge \neg A(Z_0) \implies \neg BindFlux(Z_1)$$

$$\neg BindFlux(Z_1) \implies \neg E(Z_1).$$

Let Z_2 be a 2-dimensional entity, and let Z_1 represent the properties at an internal cross-section. It follows that

$$DividesZ_2(Z_1) \wedge \neg E(Z_1) \wedge \neg A(Z_1) \implies \neg BindFlux(Z_2)$$

$$\neg BindFlux(Z_2) \implies \neg E(Z_2)$$

Let Z_3 be a purely 3-dimensional entity, and let Z_2 represent the properties at an internal cross-section ($\diamond$ means "it is possible that").

$$DividesZ_3(Z_2) \wedge \neg E(Z_2) \wedge A(Z_2) \implies \diamond BindFlux(Z_3)$$

$$\diamond BindFlux(Z_3) \implies \diamond E(Z_3)$$

Thus, the logic describing the non-existence of 0,1,2-dimensional entities doesn't apply to purely volumetric entities. QED

Remark: This undoubtedly changes many theories, but it should not be assumed that it invalidates them; rather this framework should be used to adjust concepts, and limit the number of interpretations.

3 Foundational Equations

These definitions and equations are established based on the statements in section 2. In sections 4 and 5, the field equations of modern physics are coupled to these foundational equations. In the event that physics changes models, these foundational equations remain, but the coupling process must be reestablished. The value of each property, as a function of time and space is established as follows:

$$pos : Time \times Z \to Space \tag{13}$$

$$V : \sigma \to \mathbb{R} \tag{14}$$

$$\mathcal{M} : (t, \vec{x}) \in Time \times Space \to \mathbb{R} \tag{15}$$

$$\mathcal{M}(t, \vec{x}) = \sum_{Z_i | pos(t, Z_i) = \vec{x}} V(\sigma(Z_i)). \tag{16}$$

Let $Space$ be the geometry in which all entities are spatially defined, such that

$$Space \cong \mathbb{R}^n \tag{17}$$

for some $n \geq 3$. Furthermore, $\forall \vec{x}_n \in \mathbb{R}^n$ and $\forall \vec{x}_s \in Space$,

$$\vec{x} = \vec{x}_n = \vec{x}_s, \tag{18}$$

with the mathematical Euclidean space overlaying our reality. Each mathematical symbol and operation must correspond to some element in the set

$$AE = \{Z | E(Z) \neq 0\}, \quad \text{(All Existence)} \tag{19}$$

represent distance, or describe non-existence. For example, the operation of physically combining two objects is represented by the mathematical operation of 1 + 1.

Let $\mathcal{G}(t, \vec{x}) \subset Space$, represent the geometry of the observable universe (with no implications of spacetime). Let $M(t, \vec{x})$ be defined as the restriction of $\mathcal{M}(t, \vec{x})$ over $\mathcal{G}(t, \vec{x})$, in which only elements that are both quantized and have the property of time are selected:

$$M(t, \vec{x}) := \mathcal{M}(t, \vec{x}) \restriction_{\mathcal{G}(t,\vec{x})} \restriction_{Q \cap T} \tag{20}$$

$$Q := \{Z \mid \forall \sigma,\ V_\sigma(\sigma(Z)) = nk_\sigma,\ n \in \mathbb{Z}\} \tag{21}$$

$$T := \{Z \mid Time \in \{\sigma(Z)\}\}. \tag{22}$$

The universal structure U can thus be defined as an ordered pair, as a reminder that $\mathcal{G}(t, \vec{x})$ is the geometry of $M(t, \vec{x})$,

$$U = (\mathcal{G}(t, \vec{x}), M(t, \vec{x})). \tag{23}$$

An entity is considered an object if it is technologically measurable, independent of proximity (a rock in $Space$ is still an object simply because we have the ability to measure rocks). Since AE constitutes all that exists, Z is either measurable, or an interaction results in a measurable property. Thus, define an interaction between some subset $\{Z_i\}_{i=1}^{j} \subset AE$ as

$$I_{\{Z_i\}_{i=1}^{j}}(t, \vec{x}) = M(t, \vec{x}) \restriction_{\{pos(t, Z_i)\}_{i=1}^{j}} . \quad (24)$$

This equation represents all information about the system, and is thus referred to as the wave-function of the interaction, represented as

$$\Psi^{U}_{\{Z_i\}_{i=1}^{j}}(t, \vec{x}) = I_{\{Z_i\}_{i=1}^{j}}(t, \vec{x}). \quad (25)$$

By definition, it follows that the set O of all objects, is the set of all wave functions that have a measurable magnitude,

$$O = \{\Psi^{U}_{\{Z_i\}_{i=1}^{j}}(t, \vec{x}) \mid |\Psi^{U}_{\{Z_i\}_{i=1}^{j}}(t, \vec{x})| \geq D_{\{Z_i\}_{i=1}^{j}}\}, \quad (26)$$

where $D_{\{Z_i\}_{i=1}^{j}}$ is the minimal detectable value set by the limits of current technology. Thus, let $\mathbb{P}$ be the set of all (measured) particles. It follows that

$$\mathbb{P} \subset O. \quad (27)$$

In QM, the wave-function $\Psi_{\mathcal{P}}(t, \vec{x})$ is used to statistically model a particle $\mathcal{P}$ [11, 12], while the exact state within U is that of eq. 25. When appropriate, the $\Psi^{U}_{\mathcal{P}}(t, \vec{x})$ notation will be used to represent both the measurable and unmeasurable states of the particles components. The exchange between measurable and unmeasurable states is represented as

$$Ex : \Psi^{U}_{\mathcal{P}}(t, \vec{x}) \to \{Meas., Unmeas.\}. \quad (28)$$

Let $A, B \subset \mathcal{G}$. The complete respective reference frames are

$$RF_A(t, \vec{x}) = M(t, \vec{x}) \restriction_A, \; RF_B(t, \vec{x}) = M(t, \vec{x}) \restriction_B, \quad (29)$$

and the proper time [3] in each reference frame $X \in \{A, B\}$ is a measurement of

$$\Delta\tau_X : RF_X(t_{X2}, \vec{x}_{X2}) \times RF_X(t_{X1}, \vec{x}_{X1}) \to \mathbb{R}. \quad (30)$$

Time dilation [3] occurs when $\Delta\tau_A \neq \Delta\tau_B$ over the same Δt due to two-way interactions between force carriers and the M field. For a photon γ in the RF_X reference frame

$$\gamma = \Psi^{U}_{\{Z_i\}_{i=1}^{j}} = RF_X \restriction_{\{pos(t, Z_i)\}_{i=1}^{j}} \quad (31)$$

and thus the speed of light is

$$c(\tau) = |\frac{d(pos(t, \gamma))}{d\tau_X}| = const \quad (32)$$

$$c(t) = |\frac{d(pos(t, \gamma))}{dt}| \neq const \quad (33)$$

ensuring that it is measurably invariant. From eqs. 32 and 33, it follows that the concepts of time within GR and U are related by

$$c d\tau = c(t) dt. \quad (34)$$

Using eq. 32, with γ replaced by Z, yields

$$\frac{d\vec{x}_Z}{d\tau} = \frac{d(pos(t, Z))}{d\tau_X}. \quad (35)$$

If Z is presumed to be unmeasurable, there is no known bound to eq. 35. The speed of light is fundamentally built into the geometry of spacetime [13] but that is not the case in U. In this case, the speed of light is just another speed but it happens to be the fastest that we can measure. Non-locality [14] can thus be defined, without violating causality (cause must precede effect), as an interaction that occurs faster than light (FTL), which requires that

$$Non-local(\mathcal{P}) \iff \exists Z(|\frac{d(pos(t, Z))}{d\tau}| > c). \quad (36)$$

*Equations of relativity only pertain to objects, thus avoiding complex times. This resolves the **EPR paradox** because there is no longer a conflict between the non-local nature of QM and the locality of GR. Since every measurement contains a non-zero error, $|Real - Measured| > 0$, there isn't any means to verify that entanglement is instantaneous. Since the error is below measurable quantities, for all practical purposes the equations of QFT don't have to be altered, but for theoretical purposes they should be.*

4 M And The Metric Of $\mathcal{G}$

All 4-D metrics will be interpreted using the $(-, +, +, +)$ signature, where the notation $X^{(z)}_{\mu\nu}$ indicates that $X_{\mu\nu}$ is defined with respect to the metric $z_{\mu\nu}$.

To reproduce the same physics as γ_{ij} (which doesn't include coupling terms) within U, it is necessary to express γ_{ij} as the contraction of a mixed tensor ρ^k_i with the metric of $\mathcal{G}$, namely $\chi^{(\mathcal{G})}_{kj}$. This relation is

$$\underbrace{\gamma_{ij}}_{\text{geometry of } \Sigma_t} = \frac{1}{\epsilon} \underbrace{\rho^k_i \chi^{(\mathcal{G})}_{kj}}_{\text{prop. dens. of } M \text{ in } \mathcal{G}} \quad (37)$$

where $|\epsilon| = 1$, and $[\epsilon] = \frac{[Z]}{dist^3}$. Thus, the spatial relations defined by the metric γ_{ij}, are attributed to the property density of the M field within $\mathcal{G}$. Explicitly defining $\mathcal{G}$ to be $\mathbb{R}^3$ Euclidean (which is not required in general), the effective metric ρ_{ij} within U is equal to the effective metric γ_{ij} within spacetime (aside from units), thus preserving the numerical predictions, changing only the ontology.

$$[\chi^{(\mathcal{G})}_{kj} = \delta_{kj}] \implies \frac{1}{\epsilon}\underbrace{\rho_{ij}}_{\text{Metric in } U} = \underbrace{\gamma_{ij}}_{\text{Metric in GR}} \tag{38}$$

Since time $t \in \{\sigma(Z)\}$, space and time are ontologically decoupled regardless of the mathematics. That is, $\forall \mu, \nu \in \{0, 1, 2, 3\}$, $g_{\mu\nu}$ describes U. This allows us to keep the coupling terms, to recover phenomena such as frame dragging, and to use the 4-D spacetime metric to describe the 3-D universe. The metric of U can thus be established as

$$\rho_{\mu\nu} = \underbrace{\begin{pmatrix} \epsilon(-N^2 + N_k N^k) & \epsilon N_i \\ \epsilon N_j & \rho_{ij} \end{pmatrix}}_{\text{All components of } U}, \tag{39}$$

where

$$\rho_{\mu\nu} = \epsilon g_{\mu\nu}. \tag{40}$$

To transition between time within GR and time within U, eq. 34 is used yielding the following metric equation

$$\underbrace{-\epsilon c(t)^2 dt^2}_{\text{comp. of } U} = \underbrace{\rho_{\mu\nu} dx^\mu dx^\nu}_{\text{comp. of } U}. \tag{41}$$

5 The Field Equations

The following equations transform the gravitational, scalar, fermion, and gauge fields from spacetime to U. The original expressions of each equation, denoted by $X^{(g)}$, are referenced in their corresponding sections. The first two fields are general enough that details are left out.

Gravity (Original forms: [3, 15]):

$$\Gamma^{(\rho)\mu}_{\nu\sigma} = \frac{1}{2}\rho^{\mu\lambda}\left(\partial_\nu \rho_{\sigma\lambda} + \partial_\sigma \rho_{\nu\lambda} - \partial_\lambda \rho_{\nu\sigma}\right) \tag{42}$$

$$= \Gamma^{(g)\mu}_{\nu\sigma} \tag{43}$$

$$R^{(\rho)}_{\mu\nu} = \partial_\alpha \Gamma^{(\rho)\alpha}_{\mu\nu} - \partial_\nu \Gamma^{(\rho)\alpha}_{\mu\alpha} + \Gamma^{(\rho)\alpha}_{\beta\alpha}\Gamma^{(\rho)\beta}_{\mu\nu} - \Gamma^{(\rho)\alpha}_{\nu\beta}\Gamma^{(\rho)\beta}_{\mu\alpha} \tag{44}$$

$$= R^{(g)}_{\mu\nu} \tag{45}$$

$$R^{(\rho)} = \rho^{\mu\nu} R^{(\rho)}_{\mu\nu} \tag{46}$$

$$= \frac{1}{\epsilon} R^{(g)} \tag{47}$$

$$\mathcal{L}^{(\rho)}_{EH} = \frac{1}{16\pi G} R^{(\rho)} \sqrt{-\rho} \tag{48}$$

$$= \epsilon \mathcal{L}^{(g)}_{EH} \tag{49}$$

Scalars (Original forms: [4]):

$$\mathcal{L}^{(\rho)}_\phi = -\frac{1}{2}\sqrt{-\rho}(\rho^{\mu\nu}\partial_\mu\phi\partial_\nu\phi + \frac{1}{\epsilon}m^2\phi^2) \tag{50}$$

$$= \epsilon \mathcal{L}^{(g)}_\phi \tag{51}$$

Fermions: This section is based on the work of Alcubierre [16], but with $g_{\mu\nu}$ replaced by $\rho_{\mu\nu}$ in accordance with this framework. The vierbeins are a set of four orthonormal vectors e^μ_A defined at each point of spacetime, forming a local basis, where the index $A = 0, 1, 2, 3$ labels the directions. The relationships between $\rho_{\mu\nu}$, $g_{\mu\nu}$, $\eta_{\mu\nu}$ and e^μ_A are:

$$\rho_{\mu\nu} e^\mu_A e^\nu_B = \epsilon \eta_{AB} \iff g_{\mu\nu} e^\mu_A e^\nu_B = \eta_{AB} \tag{52}$$

so the unit conversion factor ϵ doesn't change the vierbeins. The raising and lowering of indices μ, ν and A, B are done with $g_{\mu\nu}$ and $\eta_{\mu\nu}$ respectively, represented as

$$\epsilon e_{\mu A} = \rho_{\mu\nu} e^\nu_A \iff e_{\mu A} = g_{\mu\nu} e^\nu_A \tag{53}$$

$$\epsilon e^{\mu A} = \epsilon \eta^{AB} e^\mu_B \iff e^{\mu A} = \eta^{AB} e^\mu_B. \tag{54}$$

Starting with the scaled gamma functions:

$$\{\frac{\gamma^A}{\sqrt{\epsilon}}, \frac{\gamma^B}{\sqrt{\epsilon}}\} = -2\frac{1}{\epsilon}\eta^{AB}\mathbf{I}_4 \tag{55}$$

$$= -2\eta^{AB}_{(\epsilon)}\mathbf{I}_4, \tag{56}$$

where $\eta^{AB}_{(\epsilon)}$ signifies the scaled Minkowski metric, and using the relation $\gamma^\mu = \gamma^A e^\mu_A$, yields

$$\{\frac{\gamma^{(g)\mu}}{\sqrt{\epsilon}}, \frac{\gamma^{(g)\nu}}{\sqrt{\epsilon}}\} = -2\frac{1}{\epsilon}\eta^{AB} e^\mu_A e^\nu_B \mathbf{I}_4 \tag{57}$$

$$= -2\frac{1}{\epsilon} g^{\mu\nu}\mathbf{I}_4 \tag{58}$$

$$= -2\rho^{\mu\nu}\mathbf{I}_4. \tag{59}$$

The relationship between $\bar{\Psi}$ and Ψ must remain the same, and thus

$$\bar{\Psi} = \Psi^\dagger \gamma^{(\eta_\epsilon)0}\sqrt{\epsilon}. \tag{60}$$

Since the vierbeins do not change, neither does the spin-connection

$$\omega_{AB\mu} = e^\nu_B (e_{\lambda A}\Gamma^\lambda_{\mu\nu} - \partial_\mu e_{\nu A}), \tag{61}$$

and thus the Spinor covariant derivatives are related as follows:

$$\frac{D^{(g)}_\mu \Psi}{\epsilon} = \frac{1}{\epsilon}\partial_\mu \Psi - \frac{1}{4}\omega_{AB\mu}\frac{\gamma^A}{\sqrt{\epsilon}}\frac{\gamma^B}{\sqrt{\epsilon}}\Psi = D^{(\rho)}_\mu \Psi. \tag{62}$$

Thus, the relationship between Lagrangian's is:

$$\mathcal{L}^{(\rho)}_\Psi = \sqrt{-\rho}\bar{\Psi}(i\sqrt{\epsilon}\gamma^{(\rho)\mu} D^{(\rho)}_\mu - \frac{1}{\epsilon}m)\Psi \tag{63}$$

$$= \epsilon \mathcal{L}^{(g)}_\Psi. \tag{64}$$

Gauge (Original forms: [17, 18]): Let the covariant form of the Yang-Mills field strength be represented as $F^{(g)}_{\mu\nu}$. Scaling $g_{\mu\nu}$ by the constant ϵ, can only change the relationship between $F^{(\rho)}_{\mu\nu}$ and $F^{(g)}_{\mu\nu}$ by some exponent of ϵ, represented as

$$F^{(\rho)}_{\mu\nu} = \epsilon^n F^{(g)}_{\mu\nu}. \tag{65}$$

Then

$$F^{(\rho)\mu\nu} = \epsilon^{n-2} F^{(g)\mu\nu} \tag{66}$$

therefore:

$$\mathcal{L}^{(\rho)}_{YM} = -\frac{1}{2g^2_{YM}\epsilon^{2n-1}} \sqrt{-\rho}\, tr(F^{(\rho)}_{\mu\nu} F^{(\rho)\mu\nu}) \tag{67}$$

$$= -\frac{1}{2g^2_{YM}\epsilon^{2n-1}} \epsilon^2 \sqrt{-g}\, tr(\epsilon^n F^{(g)}_{\mu\nu} \epsilon^{n-2} F^{(g)\mu\nu}) \tag{68}$$

$$= \epsilon \mathcal{L}^{(g)}_{YM} \tag{69}$$

where n is determined by the field being analyzed.

6 Results

By changing the concept of time t from a dimension to an intrinsic property, GR and QFT can be mapped to the same ontological structure in which curvature is replaced by the density of the quantized M field. Thus, M becomes the causal mechanism for quantum and relativistic phenomena. With space and time decoupled, the 4-D metric describes behavior of a 3-D universe (U), thus requiring minimal changes to the field equations as follows:

$$\begin{aligned} c d\tau &= c(t) dt \quad \text{(eq. 34)} \\ \rho_{\mu\nu} &= \epsilon g_{\mu\nu} \quad \text{(eq. 40)} \\ \mathcal{L}^{(\rho)}_{EH} &= \epsilon \mathcal{L}^{(g)}_{EH} \quad \text{(eq. 49)} \\ \mathcal{L}^{(\rho)}_{\phi} &= \epsilon \mathcal{L}^{(g)}_{\phi} \quad \text{(eq. 51)} \\ \mathcal{L}^{(\rho)}_{\Psi} &= \epsilon \mathcal{L}^{(g)}_{\Psi} \quad \text{(eq. 64)} \\ \mathcal{L}^{(\rho)}_{YM} &= \epsilon \mathcal{L}^{(g)}_{YM} \quad \text{(eq. 69).} \\ &\text{(Curvature} \rightarrow \text{Density)} \end{aligned}$$

Since, $Space$, time, non-locality, and quantization are treated uniformly throughout the Lagrangian's, coherent unification (which is not a theory of everything) is established as

$$\mathcal{L}^{(\rho)}_{M} = \mathcal{L}^{(\rho)}_{EH} + \mathcal{L}^{(\rho)}_{\psi} + \mathcal{L}^{(\rho)}_{\Psi} + \mathcal{L}^{(\rho)}_{YM}. \tag{70}$$

This framework sheds light on how to deal with the following paradoxes (as well as others):

- **EPR paradox:** Eq. 36 (equations are only confirmed to apply to Objects), establishes that information can travel FTL without violating causality (the photon (currently) remains the fastest measurable Object). Entanglement is not instantaneous, or at least it can't be experimentally confirmed to be.
- **Singularities:** Claim 3 (section 2.1.1) establishes that existence requires volume.
- **Grandfather paradox / The arrow of time:** Time t is a property (not a dimension) and proper time is a measurement (section 3); the concepts of time travel and causal violation are misunderstood.
- **Why is there something rather than nothing?** By the Law of Ontological Continuity (section 2), existence has always existed for the same reason that non-existence has always not existed.
- **Cosmological Constant Problem / Renormalization:** All field equations describe different aspects of the M field (section 5), which only has physically real states (justifying the cutoff), governed by the rules of section 2 and the equations of section 3.
- **Muon decay:** Within the muon there are *two-way* force carrying particles that hold it together [11]. When the velocity of a muon increases through M, the number of interactions that force carriers have increase resulting in time dilation.

7 Discussion Of This Framework

If spacetime is temporarily assumed, then, by the Law of Spatial Isomorphism (section 2), spacetime must exist within $Space$. For spacetime to be distinguished, it therefore follows that it must ontologically exist, and not just represent a geometry. Using eq. 11, let the time domain of spacetime be represented as

$$D_{S_{spacetime}(t)} = (-\infty, \infty) = \underbrace{(-\infty, a)}_{p_1} \cup \underbrace{[a, t_{\text{now}})}_{p_2}, \tag{71}$$

where $|p_1| = |p_2|$. If one assumes the Big Bang, statistical mechanics [19] and natural causes, then either the Big Bang occurred in p_1 ($|p_1|$ is infinite), or the universe is cyclic (e.g., Conformal Cyclic Cosmology (CCC) [20]), represented as

$$Began(spacetime, p_1) \vee Cyclic(spacetime). \tag{72}$$

The finite age of the observable universe [21] establishes that $\neg Began(spacetime, p_1)$, and so the universe can only be fully described through a cyclic model. In the

CCC, the end of the universes cycle mathematically looks like the beginning, where the scale factor $a(t)$ is said to be lost as the universe expands [20]. However, by the Laws of Ontological Continuity, existence is fixed, so even if the universe expands indefinitely, the reference frame persists ensuring that the scale factor can't vanish. Similarly, the mathematical fields of physics describe ontological fields, where ontological fields require physical mechanisms. Just saying that the beginning and the end of a universe mathematically look similar, is not sufficient to establish how or why the fundamental existences that formed the universe reset to form the next cycle. This complete universal cycle therefore can't be driven by entropy contrary to [22]. That is, time t represents the perpetual property of change that drives entropy, and it need not adhere to equations known to apply to Objects. However, the answer to both Olbers' Paradox and how the universe began still need to be presented.

Within a block-universe framework, all past, present, and future events are equally real, with the parameter t specifying the spacetime hypersurface corresponding to an observer's experienced moment [23]. However, under this interpretation, there is no principled explanation for why the universe should be describable by stable mathematical laws. If the claim is that the order is structural then the existence of said structure and why it demands order, must be explained. Appeals to anthropic reasoning where observers can only arise in sufficiently ordered universes does not resolve this issue since in a fully fixed spacetime there is no logical obstruction to the spontaneous appearance of observers within highly disordered or catastrophic configurations (this is called a Boltzmann brain). Consequently, the block-universe fails to provide a reasonable account of why the universe exhibits lawful structure. Within U, the physical properties of our universe are needed to ensure that it evolves.

When dealing with mathematics and how it relates to our universe, it is easy (for me) to see how eventually one would begin to treat mathematics as real. However, mathematics doesn't exist but rather your mind/brain exists, and this permits you to comprehend concepts and ideas that don't themselves exist in reality. Thus, mathematics is only descriptive so we can't translate numerical accuracy to ontological structure, nor can we promote it to causal.

Is this framework overly simplistic? Simplicity here reflects logical consistency rather the frameworks inability to adequately explain the universe. For example, although the detailed physical descriptions of dark matter and dark energy remain unknown, both are empirically inferred to exist and therefore fall within the ontological scope of the M field. In this sense, all objects or phenomena that physics may ever discover are, by definition, contained within M ($\mathcal{G}$ might change geometry). The perceived complexity of modern physics arises not from the richness of nature, but from complications embedded in its foundational assumptions. By removing these complications, this framework reduces unnecessary conceptual complexity without limiting physical generality.

Non-existence is not synonymous with nothingness. Existence is defined by the possession of an intrinsic property; consequently, non-existence refers to the logical complement which includes nothingness. The moment that you try to conceptualize nothingness, you are imagining something, and thus nothingness can't even be conceived. For this reason, the ground state should not be associated with the term.

In *The Origin of Time In Conscious Agents* by Donald Hoffman (UC Irvine), consciousness is treated as a property. Furthermore, these conscious agents transition through a causal loop, similar to $S_Z(t)$, where perception, decision, and action form the states [24]. This aligns remarkably well with the FOE in regards to time, and establishes a rigorous framework to explore consciousness.

Free will necessitates the ability to change the value of α (Law of Self-Causation) without causal requirement. In our everyday experience there is always some underlying physical law that dictates the state of Z, but in the absence of such a law, could Z freely choose? In this context, free will requires an absence of information, laws, or restrictions, thus opening the door to it potentially being more probable than determinism. From a purely evolutionary perspective, consciousness without free will would not help one survive since they couldn't alter their actions. Does evolution therefore suggest that we have free will, or is consciousness just an unavoidable outcome?

The Law of Interaction permits multiple universes within the same spatial region (e.g., $\mathcal{G}$). In this context, universes are distinguished by distinct sets of interacting properties (or spatial separation), which aligns with the idea of a parallel universe [25] or the multiverse [26]. It therefore becomes necessary to establish a systematic method for identifying the full set of admissible properties that could identify a given universe; this likely requires a complete reliance on group theory.

The current definition of science generally requires that a claim, theory, or equation be testable. At some point, our ability to measure new aspects of reality may reach a fundamental limit, raising the question of whether science can continue to progress under such constraints. In these circumstances, we are compelled to rely on the absolute consistency of logic as a tool to explore the entirety of $\mathcal{M}$ mathematically. For this reason, I propose that science be understood more broadly as encompassing any theory derivable from the FOE (which includes all observations). To further justify this request, mathematics alone can give the wrong ontology, and without mathematical constraints, logic is insufficient to fully describe it. This illustrates the need for the FOE framework, where physics aligns with ontology, and ontology is derived from logic.

When mathematics is utilized in physics, the underlying logic is inevitably inherited. Consequently, if the mathematical theorems required for physical description can be developed using a less restrictive logic, the FOE can be further expanded. While various sub-fields of mathematics currently support such developments using (say) constructive logic, they do not yet sufficiently meet the requirements of this framework. This represents a vital frontier of research where philosophers, logicians, mathematicians, and physicists must collaborate to expand the FOE by minimizing or changing the required logical axioms to bring our understanding of the universe to levels that are incomprehensible by modern standards.

8 Conclusion

While the foundational mathematics of GR and QFT are individually consistent, certain current formulations rely on assumptions that are not simultaneously satisfied. Incompatibility between two specific formulations means that there exists a proposition P (e.g., "spacetime is dynamic") that is true in one model but not true in the other. This divergence does not constitute a formal contradiction within either theory. However, when attempting unification, it becomes unclear whether P, $\neg P$, or a reformulation of both should be retained at the fundamental level. The difficulty therefore lies in determining the deeper ontological structure from which both formulations are compatible. The only way that I know to resolve this is to first step away from physics entirely and derive equations that are much more fundamental because they only depended on existence itself. By structuring these foundational equations such that all known phenomena have a classical explanation and then tying the field equations of physics to them, the same ontological field becomes the mechanism for all observables. The unifying ontology therefore clarifies what the meaning of space and time are in reality. When you develop physics in this way, it sheds light on how we can resolve paradoxes.

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Declaration of AI Formatting

No AI system contributed original scientific ideas, theoretical content, or conceptual development, nor is AI currently capable of doing so to the best of the author's knowledge. Gemini was used as an aid for personal study, and ChatGPT reformatted pre-written paragraphs. The FOE framework (rough) on which this research is based was published before the wide-spread use of AI in science (2024), where new contributions were made to refine it and to establish that it works.

Verification and Peer Review

The author maintains a firm commitment to the peer-review process as the standard for scientific validation. Until such time as this work is formally published in a peer-reviewed journal, the reader is encouraged to treat these findings as a foundational proposal and to verify all results independently.

Iterative Development

This framework has (unofficially) undergone extensive stress-testing and refinement. Its current form is the product of rigorous academic debates between myself and specialists in the related fields. The above claims and statements represent the details that survived.

Competing Interests

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